Remarks

Claims 1-20 were pending in the application. Claims 1-20 were rejected. No claims were merely objected to and no claims were allowed.

Claim Rejections-35 U.S.C. 112

Claims 1-13 were rejected under 35 U.S.C. 112(1). Applicants respectfully traverse the rejection.

It was asserted that "electro-graphitic carbon" did not appear to be a recognized term of art. Applicants disagree. As is noted below, the material (also known in non-hyphenated form and by the acronym EGC), is known typically from electrical applications and often referred to merely as electrographite. These are discussed further below. Attached, for example, is ASTM C 709-06 which has definitions for electrographite/manufactured graphite (pages 1&3). See also references to "electro-graphitic" in US5311615, discussed below. Although various alternative terms are used, the references to electro-graphitic or electrographitic carbon would be regarded as clear in the art. Accordingly, the rejection is believed overcome.

Claim Rejections-35 U.S.C. 102/103

Claims 1-3, 7-9, and 13 were rejected as being anticipated by Naudet et al. (US4706354). Claims 4-6 and 10-12 were rejected under 35 U.S.C. 103(a) as being unpatentable over Naudet et al. in view of Official Notice. Applicants respectfully traverse the rejections.

Naudet et al. discloses use of "an automotive lubricating material… such as carbon or graphite" Col. 3, ~line 55. There is no suggestion for this to be electrographitic carbon. The reference to "automotive lubricating material" evidences that Naudet et al. were not considering electrographite/EGC.

Prior art use of graphite-filled polyimide is described as the relevant prior art in paragraph 0003 of the present application. There is no reason to believe that Naudet et al. is anything more than this. At higher temperatures, the polyimide resin will suffer a loss of mechanical properties and surface stability resulting in failure of the bushing.

The independent claims identify the electrographitic carbon. Electrographitic carbon (EGC) is typically used in electrical applications such as motor brushes (see US 5311615) and electro-discharge machining (EDM) electrodes. EGC, however, has significantly higher

thermo-tolerance than the cited polyimide prior art. See, paragraphs 0011 and 14 of the present application. These identify EGC operational temperatures of 850°F and 1050°F (also added dependent claims). Advantageous EGC performance data is identified in paragraph 0014. Thus there is further no suggestion for these temperatures.

Accordingly, Applicants submit that claims 1-20 are in condition for allowance. Reconsideration and further examination are requested. Please charge any fees or deficiency or credit any overpayment to our Deposit Account of record.

Respectfully submitted,

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Enclosure: ASTM C 709-06

Designation: C 709 – 06

An American National Standard

Standard Terminology Relating to Manufactured Carbon and Graphite[1]

This standard is issued under the fixed designation C 709; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

across (or against) grain, *n*—direction in a body with preferred orientation due to forming stresses that has the maximum *c*-axis alignment as measured in an X-ray diffraction test.

agglomerate, *n*—*in manufactured carbon and graphite product technology*, composite particle containing a number of grains.

anistropic nuclear graphite, *n*—graphite in which the isotropy ratio based on the value of the coefficient of thermal expansion (25–500°C) is greater than 1.15.

ash, *n*—*in carbon and graphite technology*, residue remaining after oxidation of a carbon or graphite.

binder, *n*—substance, usually an organic material such as coal tar pitch or petroleum pitch, used to bond the coke or other filler material prior to baking.

carbon, *n*—element, number 6 of the periodic table of elements, electronic ground state $1s^2 2s^2 2p^2$.

carbon, *n*—*in carbon and graphite technology*, artifact consisting predominantly of the element carbon and possessing limited long range order.

Discussion—The presence of limited long range order is usually associated with low electrical and thermal conductivity and difficult machinability when compared with graphite.

carbon foam, *n*—*in carbon and graphite technology*, porous carbon product containing regularly shaped, predominantly concave, homogeneously dispersed cells which interact to form a three-dimensional array throughout a continuum material of carbon, predominantly in the non-graphitic state. The final result is either an open or closed cell product.

Discussion—In most foam, the cell wall thickness is less than half the average cell size.

cell (bubble), *n*—*in carbon and graphite technology*, single small cavity formed by gaseous displacement in a precursor material in its plastic state, and surrounded completely by its walls when formed. Cells can be open or closed.

Discussion—After processing at high temperatures, the basic structure of the cell will remain even as the material converts from a plastic state to a rigid carbonaceous structure. Hence, the term cell will apply to a carbon product.

cell count, *n*—*in carbon and graphite technology, in closed-cell foams*, number of cells aligned in one plane in one linear inch, as determined by stereoscopic image analysis.

cell size, *n*—*in carbon and graphite technology*, average diameter of the cells in the final foam product.

closed cell, *n*—*in carbon and graphite technology*, cell totally enclosed by its walls and hence not interconnected with other cells. A closed cell foam is a foam consisting predominantly of closed cells.

coke, *n*—carbonaceous solid produced from coal, petroleum, or other materials by thermal decomposition with passage through a plastic state.

compressive strength, *n*—property of solid material that indicates its ability to withstand a uniaxial compressive load.

defect, *n*—*of a manufactured carbon or graphite product*, any irregularity in the chemistry, microstructure, or macrostructure.

defective, *adj*—having flaws or dimensional deviations greater than acceptable for the intended use.

electrographite, *n*—*in carbon and graphite technology*, synonym for manufactured graphite.

extruded, *v*—formed by being forced through a shaping orifice as a continuous body.

filler, *n*—*in manufactured carbon and graphite product technology*, carbonaceous particles comprising the base aggregate in an unbaked green-mix formulation.

flaw, *n*—defect sufficiently greater than those typical of the morphology of a carbon or graphite body to influence a property.

flexural strength, *n*—property of solid material that indicates its ability to withstand a flexural or transverse load.

flow line, *n*—defect induced by discontinuous flow velocities during forming of molded or extruded bodies.

grade, *n*—designation given a material by a manufacturer such that it is always reproduced to the same specifications established by the manufacturer.

grain, *n*—*in manufactured (synthetic) carbon and graphite*, particle of filler material (usually coke or graphite) in the

[1] This terminology is under the jurisdiction of ASTM Committee D02 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.F0 on Manufactured Carbon and Graphite Products.

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starting mix formulation. Also referred to as granular material, filler particle, or aggregate material. The term is also used to describe the general texture of a carbon or graphite body, as in the descriptions listed below:

coarse grained, adj—containing grains in the starting mix that are substantially greater than 4 mm in size.

fine grained, adj—containing grains in the starting mix that are generally less than 100 µm in size.

medium grained, adj—containing grains in the starting mix that are generally less than 4 mm in size.

microfine grained, adj—containing grains in the starting mix that are generally less than 2 µm in size.

superfine grained, adj—containing grains in the starting mix that are generally less than 50 µm in size.

ultrafine grained, adj—containing grains in the starting mix that are generally less than 10 µm in size.

DISCUSSION—All of the above descriptions relate to the generally accepted practice of measuring the sizing fractions with a criterion that 90 % of the grains will pass through the stated screen size in a standard particle sizing test.

graphene layer, *n—in carbon and graphite technology*, single carbon layer of the graphite structure, describing its nature by analogy to a polycyclic aromatic hydrocarbon of quasi-infinite size.

DISCUSSION—The term graphite designates a modification of the chemical element carbon in which planar sheets of carbon atoms, each atom bound to three neighbors in a honeycomb-like structure, are stacked in a three dimensional regular order. For a single layer, it is not correct to use the term graphite, which implies a three dimensional structure.

graphite, *n*—allotropic crystalline form of the element carbon, occurring as a mineral, commonly consisting of a hexagonal array of carbon atoms (space group $P6_3/mmc$) but also known in a rhombohedral form (space group R 3m).

graphite, *n—in carbon and graphite technology*, material consisting predominantly of the element carbon and possessing extensive long-range three-dimensional crystallographic order as determined by X-ray diffraction studies.

DISCUSSION—The presence of long-range order is usually accompanied with high electrical and thermal conductivity within the hexagonal plane. This results in a material having relatively easy machinability when compared to non-graphitic materials. The use of the term *graphite* without reporting confirmation of long-range crystallographic order should be avoided as it can be misleading.

graphite foam, *n—in carbon and graphite technology*, porous graphite product containing regularly shaped, predominantly concave, homogeneously dispersed cells which interact to form a three-dimensional array throughout a continuum material of carbon, predominantly in the graphitic state. The final result is either an open or closed cell product.

DISCUSSION—In most foam, the cell wall thickness is less than half the average cell size.

graphitic, *adj—in carbon and graphite technology*, all varieties of substances consisting predominantly of the element carbon in the allotropic form of graphite irrespective of the presence of structural defects.

DISCUSSION—The use of the term graphitic is justified if three-dimensional hexagonal crystalline long-range order can be detected in the material by X-ray diffraction methods, independent of the volume fraction and the homogeneity of distribution of such crystalline domains. Otherwise, the term non-graphitic should be used.

graphitizable carbon, *n—in carbon and graphite technology*, non-graphitic carbon, which, upon graphitization, converts into graphitic carbon (also known as a soft carbon).

graphitization, *n—in carbon and graphite technology*, solid-state transformation of thermodynamically unstable non-graphitic carbon into graphite by thermal treatment.

DISCUSSION—The degree of graphitization is a measure of the extent of long-range 3D crystallographic order as determined by diffraction studies only. The degree of graphitization affects many properties significantly, such as thermal conductivity, electrical conductivity, strength, and stiffness.

DISCUSSION—A common, but incorrect, use of the term graphitization is to indicate a process of thermal treatment of carbon materials at T > 2200°C regardless of any resultant crystallinity. The use of the term graphitization without reporting confirmation of long range three dimensional crystallographic order determined by diffraction studies should be avoided, as it can be misleading.

green carbon, *n*—formed, but unfired carbon body.

hard carbon, *n*—see *non-graphitizable carbon*.

hardness, *n*—resistance of a material to deformation, particularly permanent deformation, indentation, or scratching.

impervious carbon, *n*—same as impervious graphite with the exception that the base stock has not been graphitized.

impervious graphite, *n*—manufactured graphite that has been impregnated with a resinous material to make the final article impervious to liquids in the recommended operating range.

impregnation, *n*—partial filling of the open pore structure with another material.

isotropic, *adj—in carbon and graphite technology*, having an isotropy ratio of 0.9 to 1.1 for a specific property of interest.

isotropic nuclear graphite, *n*—graphite in which the isotropy ratio based on the coefficient of thermal expansion (25–500°C) is 1.00–1.10.

isotropy ratio, *n—in carbon and graphite technology*, ratio of a given property value in the against grain direction to its corresponding value in the with grain direction (for example, the ratio of coefficients of thermal expansion).

lamination, *n*—line of demarcation or elongated void generally parallel to the principal grain direction of a carbon or graphite body.

longitudinal sonic pulse, *n*—sonic pulse in which the displacements are in the direction of propagation of the pulse.

machinability, *n*—measure of the ease with which a material can be shaped with the aid of cutting or abrasive tools.

manufactured carbon, *n*—bonded granular carbon body whose matrix has been subjected to a temperature typically between 900 and 2400°C.

manufactured graphite, *n*—bonded granular carbon body whose matrix has been subjected to a temperature typically in excess of 2400°C and whose matrix is thermally stable below that temperature.

molded, *v*—formed in a closed die by the application of external pressure.

natural graphite, *n—in carbon and graphite technology,* material consisting predominantly of graphitic carbon, which forms in the earth's crust as the result of igneous or metamorphic processes acting on carbonaceous materials.

DISCUSSION—The degree of crystalline perfection in these materials may vary. Natural graphite may contain significant quantities of gangue materials, either attached to or intercalated with graphitic carbon.

near-isotropic nuclear graphite, *n*—graphite in which the isotropy based on the coefficient of thermal expansion (25–500°C) is 1.10–1.15.

non-graphitizable carbon, *n—in carbon and graphite technology,* carbon which cannot be transformed into graphitic carbon solely by heat treatment up to 3000°C under inert atmosphere or reduced pressure (also known as a hard carbon).

open cell, *n—in carbon and graphite technology,* cell that is not totally enclosed in its walls and hence interconnected with other cells. An open-cell foam is a foam consisting predominantly of open or connected cells.

orientation (of a crystal), *n*—angular position of a crystal described by the angles which certain crystallographic axes make with the frame of reference.

orientation (of a grain), *n*—angular position of a grain described by the angles which a defined set of axes of the grain make with the stated frame of reference. Generally used to characterize the axis of the grain that has the largest physical extent, for example, in a grain of needle coke.

orientation (of an object), *n*—angular position of an object described by the angles which a defined set of axes or surfaces of the object make with the frame of reference.

oxidation of carbon, *n*—chemical combination of carbon with oxygen or oxygen-containing compounds.

particle sizing, *v*—segregation of granular material into specified particle size ranges.

penetration, *n*—depths to which one material extends into or penetrates another.

permeability, *n*—property measured by the rate of passage of a fluid under a pressure gradient through a material.

pore, *n*—see *void.*

pore, *n—in carbon and graphite technology, in a carbon or graphite foam,* passage that interconnects two cells.

pore count, *n—in carbon and graphite technology, in open-cell foams,* number of pores aligned in one plane in one linear inch, as determined by stereoscopic image analysis.

porosity, *n*—percentage of the total volume of a material occupied by both open and closed pores.

preferred orientation, *n—in manufactured carbon and graphite product technology,* alignment in the crystal or defect structure of a body leading to variations in physical properties as a function of direction; normally referenced to an orthogonal system where one of the axes is the working direction.

pulse travel time (T_t), *n*—total time, measured in seconds, required for the sonic pulse to traverse the specimen being tested, and for the associated electronic signals to reverse the circuits of the pulse-propogation circuitry.

pyrolytic graphite, *n—in carbon and graphite technology,* artifact consisting predominantly of graphite which was deposited as a solid on a hot surface by cracking of gaseous or liquid hydrocarbons.

reactivity, *n*—rate at which another material will form compounds with carbon or graphite.

reticulated foam, *n—in carbon and graphite technology,* foam with a ligamentous structure rather than a spherical pore structure.

soft carbon, *n*—see *graphitizable carbon.*

surface finish, *n*—geometric irregularities in the surface of a solid material. Measurement of surface finish shall not include inherent structural irregularities unless these are the characteristics being measured.

tensile strength, *n*—property of solid material that indicates its ability to withstand a uniaxial tensile load.

ultimate tensile strength, *n*—highest load attained during a tensile test, converted to unit stress based on the original cross-section area of the tensile test specimen.

void, *n*—unfilled space enclosed within an apparently solid carbon or graphite body.

with grain, *n*—direction in a body with preferred orientation due to forming stresses that has the maximum *a*-axis alignment as measured in an X-ray diffraction test.

working direction, *n—in manufactured carbon and graphite product technology,* direction of applied force used in forming a solid body; generally the direction of applied molding pressure for a uniaxially molded material and the extrusion direction for an extruded material.

zero time (T_o), *n*—travel time (correction factor), measured in seconds, associated with the electronic circuits in the pulse propagation system.